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TRANSMUTATIONS WITH HIGH ENERGY DEUTERONS AND HELIUM IONS IN THE 184-INCH CYCLOTRON

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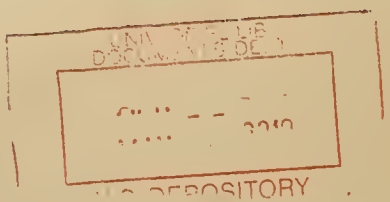

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TRANSMUTATIONS WITH HIGH ENERGY DEUTERONS AND HELIUM IONS IN THE 184-INCH CYCLOTRON

By B. B. Cunningham, H. H. Hopkins, M. Lindner, D. R. Miller, P. R. O'Connor, I. Perlman, G. T. Seaborg, and R. C. Thompson

The successful operation[1] of the Berkeley 184-inch cyclotron to produce useful beams of deuterons and helium ions of approximately 200 and 400 Mev, respectively, has made possible the radiochemical identification of many of the transmutation products of nuclei excited to very high energies. Products with considerably lower atomic number than the target were observed in all cases. For example, with 200 Mev deuterons on $_{33}As^{75}$ activities were found representative of all elements from $_{34}Se$ to $_{25}Mn$ with lower elements not excluded. Both negative beta-particle and positron (or orbital electron capture) activities are noted, indicating reactions both of multiple neutron ejection and multiple charged particle ejection. For example with deuterons on $_{51}Sb^{121}$ and ^{123} both 6.7-hour $_{48}Cd^{107}$ and 2.5-day $_{48}Cd^{115}$ were produced and with $_{33}As^{75}$ cobalt activities tentatively assigned to $_{27}Co^{55}$ or $_{27}Co^{54}$ (~12 Hr.) and $_{27}Co^{61}$ (~1.8 Hr.) [2] were found.

For the formation of light isotopes, several different reactions are possible since in most cases the products will not be shielded from formation through a chain of short-lived positron (or orbital electron capture) ancestors following the ejection of different combinations of neutrons and charged particles in the primary reaction. As an example from deuterons on $_{29}Cu^{63}$ and ^{65}, the formation of a new 8-hour iron positron emitter assigned to $_{26}Fe^{52}$ may be represented by the expression, $Cu^{63}(d,4z13a)Fe^{52}$, which indicates that four units of charge and thirteen mass units are lost in arriving at the product. In the case of the heavier isotopes it may be possible to write somewhat more definite reactions of the type $Sb^{123}(d,2a2n)Cd^{115}$ and $As^{75}(d,p3a3n)Co^{61}$, although negative beta-particle emitting parents are certainly possible.

Uranium was bombarded with 400 Mev helium ions and a wide range of activities were identified both in the heavy element region and in the region of the fission products. Representative of the heavy isotopes observed were $_{88}Ra^{223}$(AcX), $_{88}Ra^{224}$(ThX), and $_{85}At^{211}$. The fission product distribution is characterized by a much shallower dip between the maxima than is the case for slow neutron fission, and the yields of the lightest observed fission products are much higher.

The various aspects of this work will be published more fully by the individual groups of investigators.

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